Evaluation of the Digital Opacity Compliance System (DOCS) at Military and Commercial Industrial Sites

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Technical Evaluation Program

- USEPA Emissions Measurement Center (RTP, NC)
- USEPA – Region 6 (Dallas, TX)
- Tyndall AFB (Panama City, FL)
- Wright Paterson AFB (Dayton, Ohio)
- Hill AFB (Ogden, UT)
- Eastern Technical Associates (Raleigh, NC)
- Scientech Inc. (Layton, UT)

OUTLINE

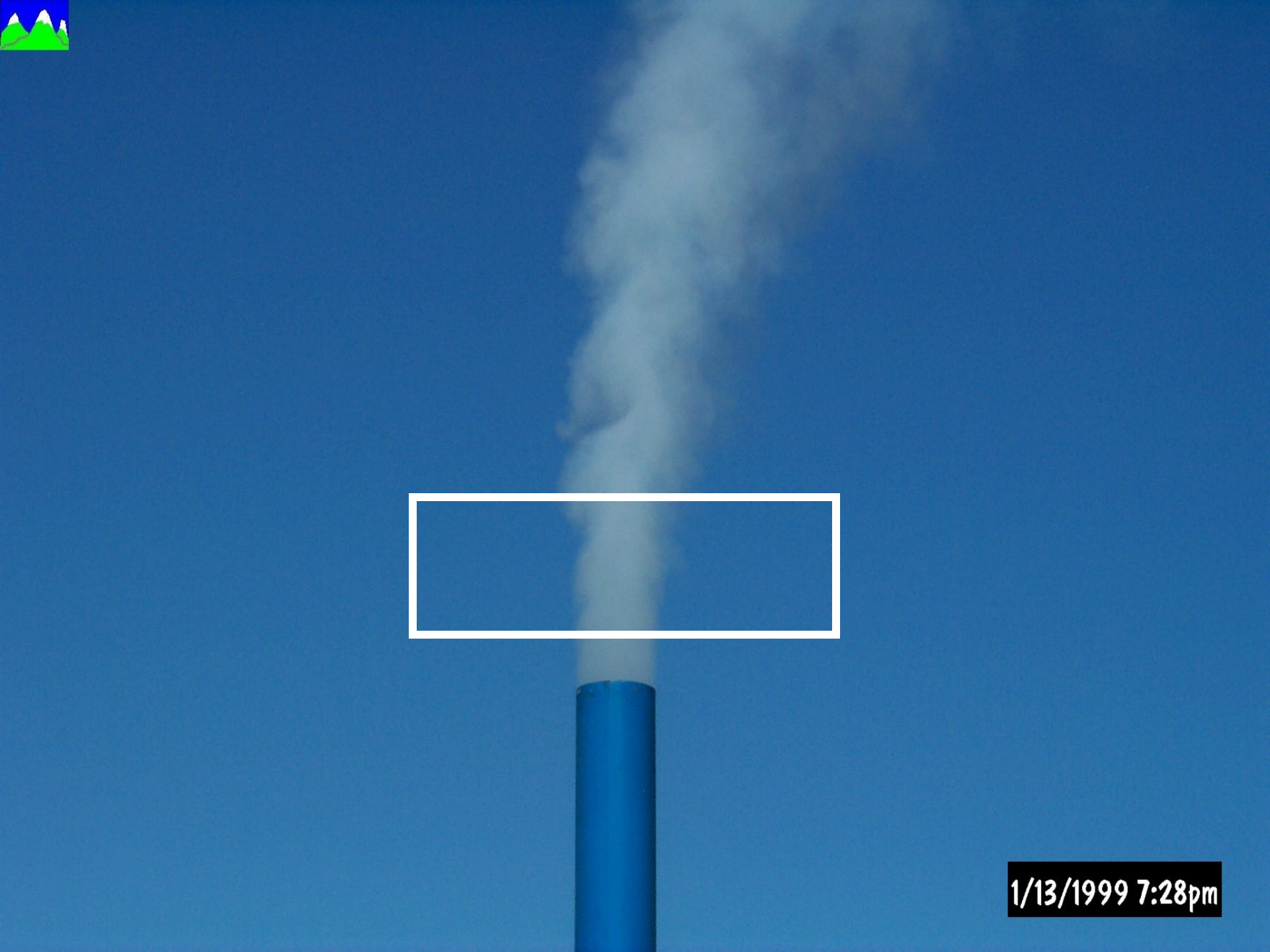
- Study Objectives
- Basic Operation of the Digital Opacity Compliance System
- Criteria for establishing Method 9 Equivalency
- Summary of data collected at field sites
- Conclusions

Study Objectives

- **Verify that the technical principles that underlie the DOCS technology are based on sound science**
- **Determine if the accuracy of DOCS in measuring opacity is statistically equivalent to EPA Reference Method 9**
- **Compare the performance of DOCS relative to EPA certified smoke readers**

Evaluation of the DOCS at EPA Approved Method 9 Smoke Schools

- September 2001 – Ogden, UT
- December 2001 – Augusta, GA
- March 2002 – Columbus, OH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Criteria for Establishing Equivalency with EPA Method 9

- DOCS – transmissometer
- ≤ 7.5%

At the 99% confidence level

Ogden, UT Smoke School Weather Conditions

	Day 1	Day 2	Day 3
Mean Temperature (□ F)	66.2	60.8	60.8
Average Wind Speed (mph)	8.1	8.9	9.7
Sky Conditions	Clear	Clear	Clear
Relative Humidity (percent)	30.5	27.2	45.2
Precipitation (in.)	0	0	0
Vertical Sun Angle (degrees)	42.2	39.4	

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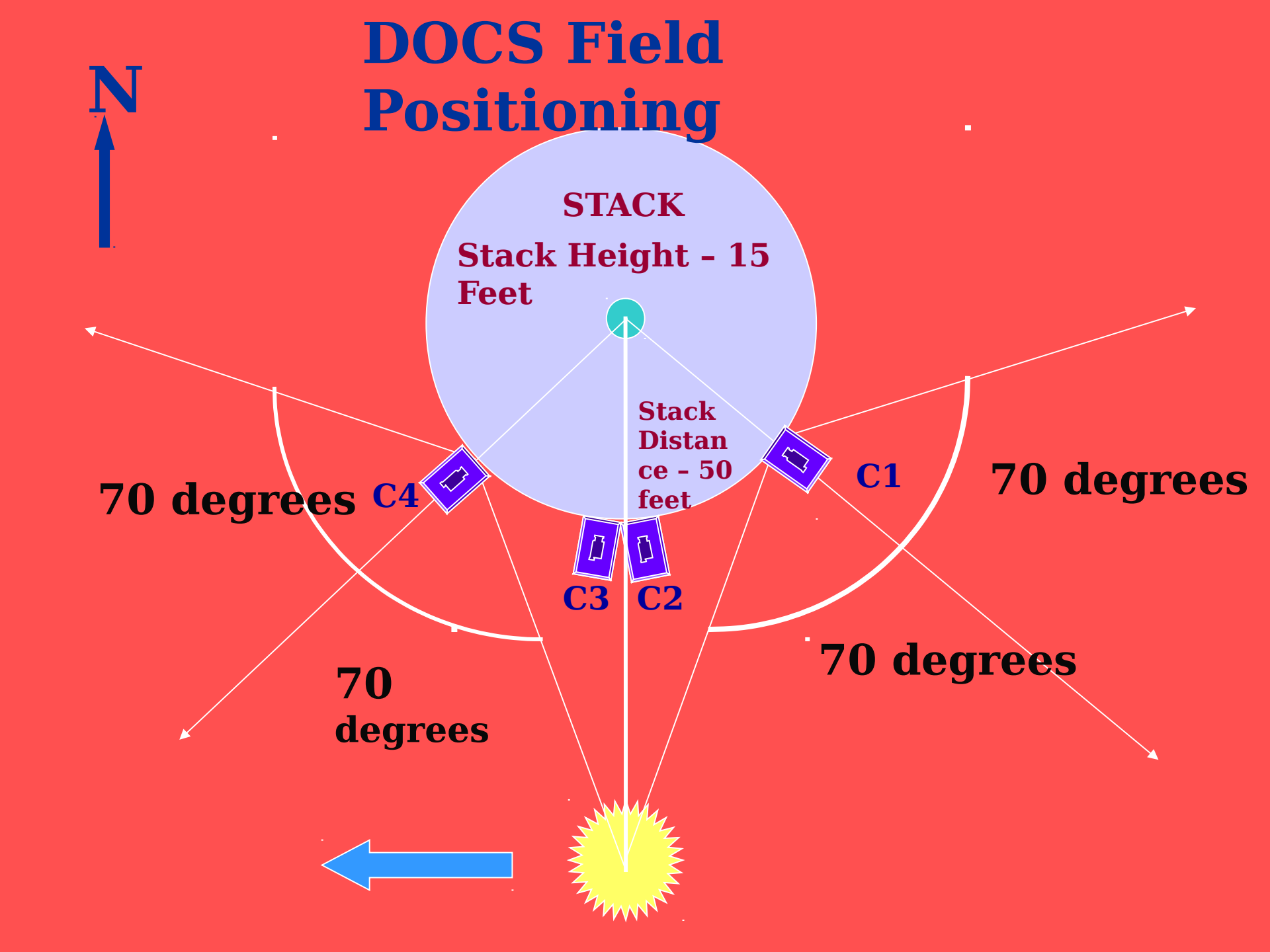
DOCS Field Positioning



DOCS Results from Ogden, UT EPA Approved Smoke School

Color of Smoke Samples	Opacity Range 99 % CI	Ave. Dev.	No. of
Black	0 – 40% 4.9 - 5.8	5.4	1745
White	0 – 40% 5.4 – 6.3	5.9	1686

August, Ga. EPA Approved Method 9 Smoke School

11/1/2001 09:17

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Columbus, Ohio EPA Approved Method 9 Smoke School

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For all opacity ranges evaluated in Ohio, neither the DOCS nor Method 9 Certified Human Observers were able to achieve the Method 9 Accuracy Standard

Differences Between UT, GA and OH Smoke School Results

- With relatively short stack heights (15 feet), human observers can employ background other than sky

- The DOCS is limited to only using sky as background and is therefore highly dependent on weather conditions.

Field Deployment of DOCS at Military and Commercial Sites

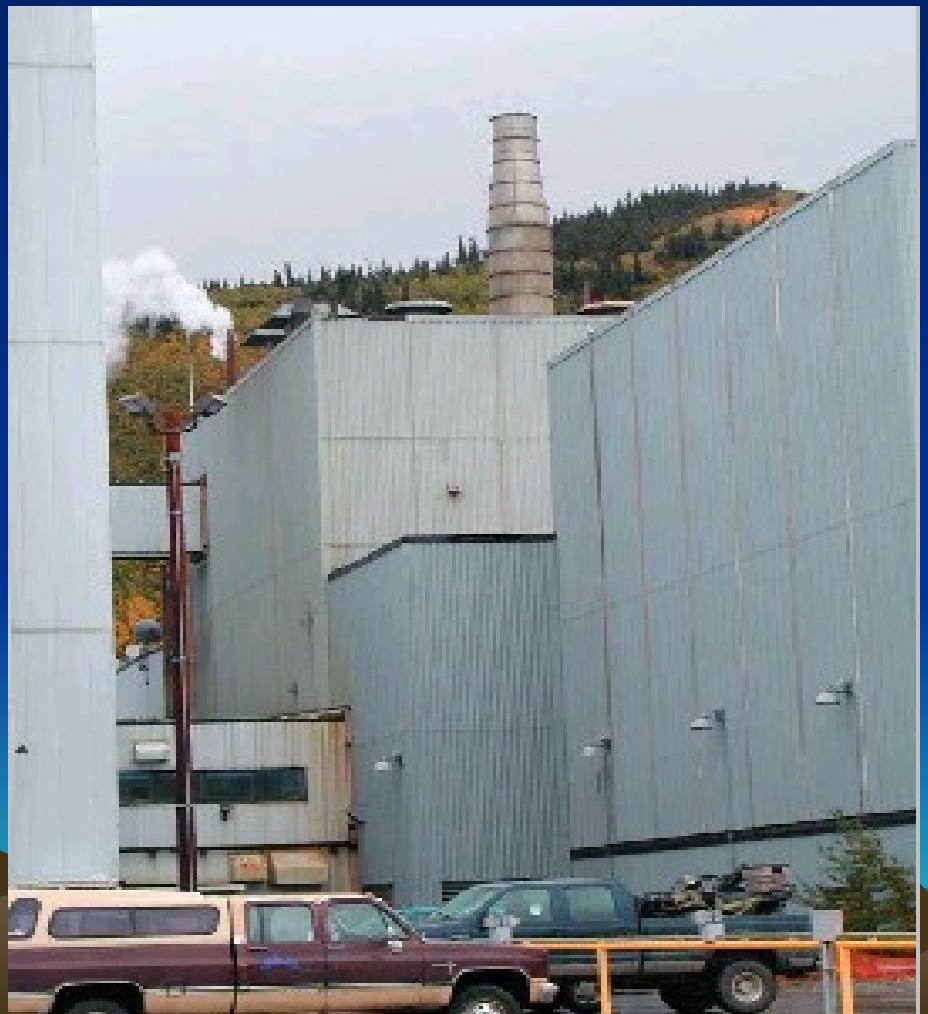
- Four (4) commercial-of-the-shelf (COTS) digital cameras were utilized
- DOCS camera operators were allowed to position themselves in any valid Method 9 location relative to the stack

Field Deployment of DOCS at Military and Commercial Sites

- Waste incinerator in Anchorage, AK
- EPA-approved smoke generator in Anchorage, AK
- Coal-fired power plant in Healy, AK
- Coal fired boiler at Eielson AFB, AK
- Diesel-fired pump station in Fairbanks, AK

Only the EPA-approved smoke generator in Anchorage, AK and the coal-fired power plant in Healy, AK, were equipped with continuous opacity monitors (COM).

Coal Fired Power Plant – Healy, AK



Average Weather Conditions at Alaska Field Sites

	Anchorage, AK	Healy, AK
Mean Temperature (° F)	54.0	41.9
Average Wind Speed (mph)	4.5	1.2
Sky Conditions	Rain Overcast	Mist Overcast
Relative Humidity (%)	100.0	96%
Precipitation (in.)	0.82	0.00
Vertical Sun Angle (°)		

Results from Systems Equipped with Continuous Opacity Monitors (COM)

Opacity Measurement Approach	Opacity Range	Ave. Dev.	Sample No.	99% CI
DOCS:COM	0 – 100%	14.1	215	11.6 – 16.6
Observer:COM	0 – 100%	6.0	224	5.2 – 6.8

Results from Facilities Equipped with COM

- Method 9 certified readers appeared to generate opacity readings that were more consistent with the COM opacity readings
- Results were not surprising given the response of DOCS during overcast weather conditions encountered during smoke school field tests

Waste Incinerator – Anchorage, AK

Results from Systems Not Equipped With Continuous Opacity Monitors (COM)

Opacity Measurement Approach	Max. Opacity	Ave. Dev.	Sample No.
99% CI			
DOCS:Observer	100%	10.5	360
8.9 – 12.2			
DOCS:Observer	40%	5.0	255
3.7 – 6.3			

Results from Systems Not Equipped with Continuous Opacity Monitors (COM)

- **Over the full range of opacity evaluated, on average, the difference between the DOCS and certified human observers was approximately 10.5 %.**

- **Over an opacity range of 0 to 40%, the DOCS consistently reported opacity readings that were, on average, within 5% of those reported by Method-9-certified human observers**

CONCLUSIONS

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- **The use of human observers to quantify opacity is inherently subjective**

- **With increasing public pressure to reduce airborne particulate matter, there is a clear need to increase in both the accuracy and reproducibility of the methods employed to verify the level of visible opacity**

CONCLUSIONS

- The DOCS technology can accurately and reliably measure the opacity of smoke plumes when weather conditions provide optimum color contrast between plume and background

- During DOCS field deployment at the military and industrial facilities, climatic conditions were characterized by light rain and overcast skies, which are unfavorable for utilization of the DOCS

CONCLUSIONS

- Over an opacity range of 0 to 40%, the DOCS consistently reported opacity readings that were, on average, within 5% of those reported by Method-9-certified human observers

- The conservative response of the DOCS is a potentially useful characteristic of the technology particularly for those facilities that desire to establish a reliable margin of safety in complying with regulated opacity levels

QUESTIONS?
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